PRS - PROFIBUS DP Redundancy Switch

User's Guide

V1.6/29.03.2010

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1 Introduction

PRS – PROFIBUS DP Redundancy Switch is an intelligent top-hat rail based switch for the implementation of redundant PROFIBUS DP Master systems. PRS allows the connection of two identical DP Masters as well as the DP Slaves. In case of failure of the operational DP Master PRS physically switches over to the stand-by DP Master which seamlessly takes over the DP Slaves.

Figure 1: PRS

2 Hardware Installation

2.1 Assembly on top-hat rail

The PRS module is designed for top-hat rail assembly according to DIN 50022. Please put the top edge of the cut-out for the top-hat rail on the top-hat rail edge and press the device down until it snaps in. For the disassembly remove the two notches at the bottom edge and, lift up the module.

2.2 Connections and controls

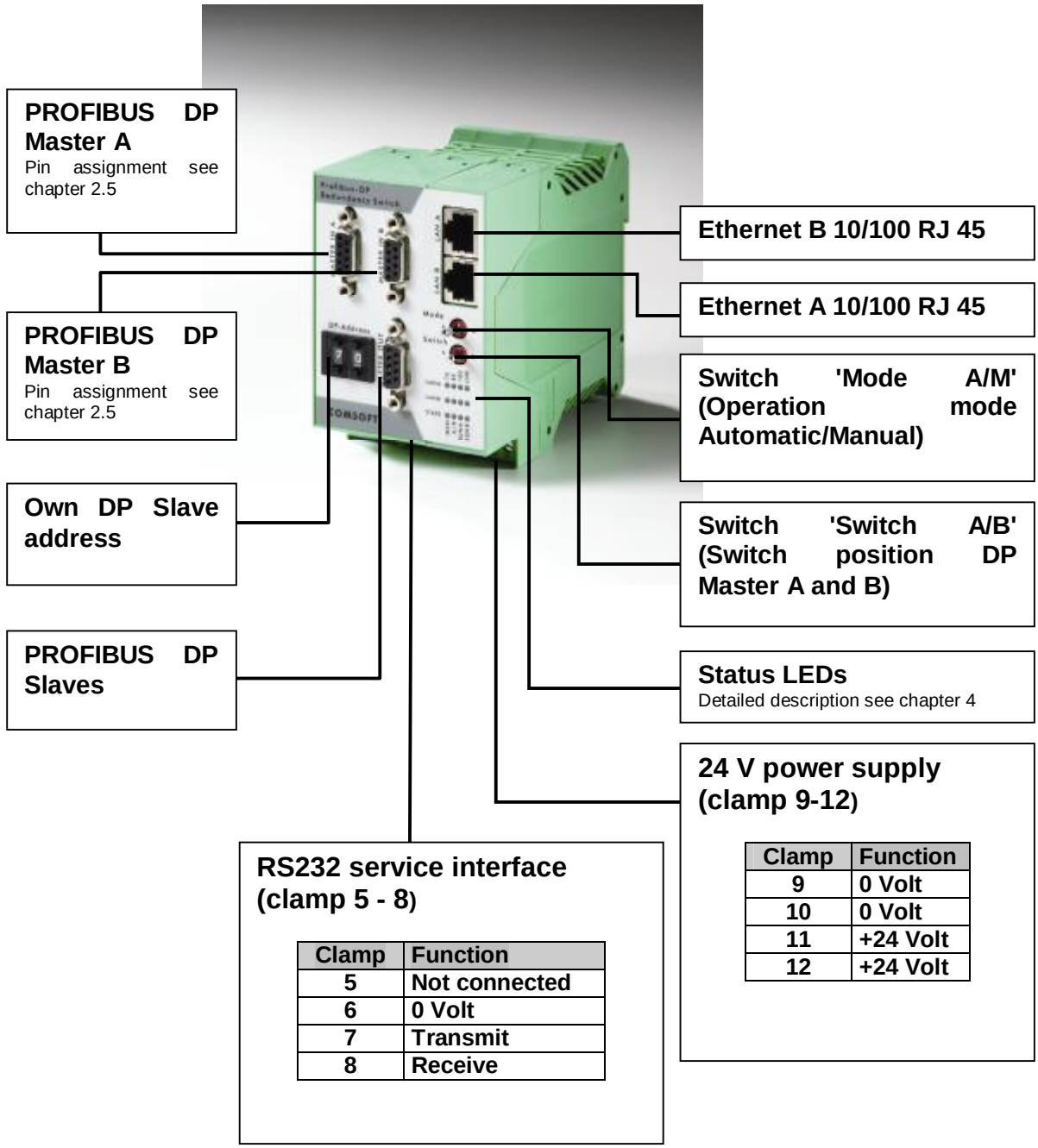

Figure 2: PRS – Connections and Controls

2.3 Power supply connection

The power supply basis for the PRS module is 24 V DC. The following options exist:

- 0 V is connected either to clamp 9 or 10,
  +24 V to clamp 11 or 12
- The resulting free clamp can be used for distributing the power supply to other 24 V devices in the cabinet
- The four clamps are combined in one coded plug. This makes it impossible to confuse the plug with other plugs. It can be inserted manually and removed again with a screwdriver.

2.4 Ethernet connection

PRS implements two Ethernet interfaces 10/100baseTX via RJ45 plugs. For connection to an existing network, connect PRS to the corresponding hub or switch via patch cable. For direct connection without use of a hub or switch, you need a cross-wired Ethernet cable.

2.5 PROFIBUS DP connection

Both DP Masters and the DP Slaves are connected to the 9 pin D-SUB plugs in the front panel of PRS as shown in Figure 5: Connection of DP Master/DP Slaves.

The termination in the PROFIBUS plugs must be deactivated if connected to the PRS.

Pin	Signal	Function	Direction
1	-	Shield	
3	R x D / T x D - P	Data+	Input/Output
8	R x D / T x D - N	Data-	Input/Output

Table 1: PROFIBUS Pin assignment

2.6 RS232 service interface

To configure PRS, terminals can be connected via the RS232 service interface (RS232/V24). The terminal is usually a PC with corresponding terminal emulation. We recommend a hyper terminal under Windows. What you can control or observe via the terminal is described in the section „Operation of PRS“.

Clamps 5...8 serve as terminal connection and as 24 V output for the internal PA power supply.

Clamp 6: 0 V for the RS232 interface.

Clamp 7: outgoing data line of the RS232 interface from viewpoint of the PRS.

Clamp 8: incoming data line of the RS232 interface from viewpoint of the PRS.

2.6.1 Pin assignment RS232 interface cable

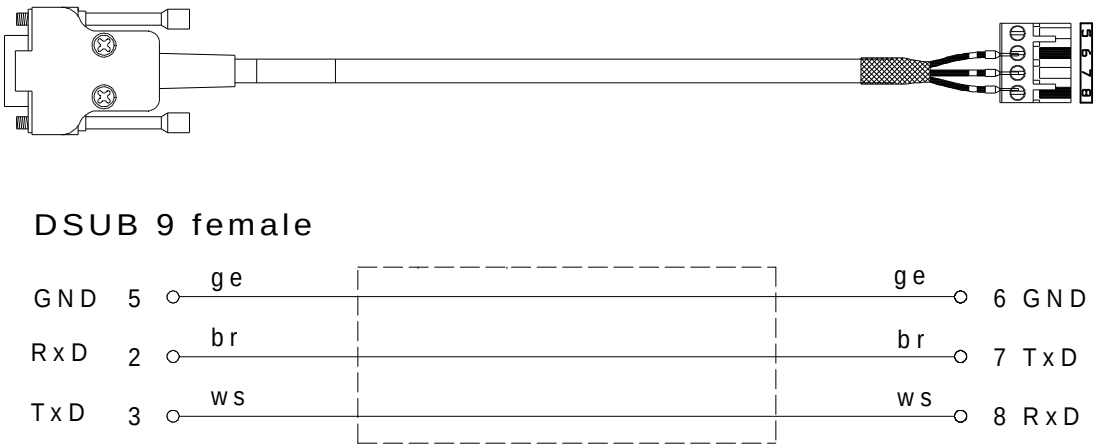

Figure 3: Serial interface cable

3 Technical data

PRS	G61740x
Dimensions	114,5 mm x 99 mm x 45 mm
Environmental temperature during operation	0..40 °C
Environmental temperature during storage	-40...100 °C
Safety	EN60950
Electromagnetic compatibility (EMV)	EN50081-2 and EN50082-2

Table 2: Technical Data I

PRS	B617401
Processor	NET+ARM50
Clock pulse frequency	44 MHz
Storage	2 MB SDRAM, 1 MB Flash
Power supply	12..36 V, nom. 24V DC
Current consumption	At 24 V: max. 120 mA
Ethernet	2 * 10/100baseTX
Dielectric strength Ethernet	1500 VAC

Table 3: Technical Data II

PRS DP module	B617402
PROFIBUS chip	2 * SPC42
Bus interface	PROFIBUS DP in accordance to EN50170
Max. speed	12 Mbit/s
Dielectric strength	500 VAC
Current consumption	At 24 V: max. 100 mA (is supplied by NET + ARM module)

Table 4: Technical Data III

4 Integrated LEDs

PRS implements status LEDs separated for DP Master A and B as well as for PROFIBUS DP and LAN.

4.1 LEDs in the LAN section

The LEDs indicate the specific operating state of the Ethernet interfaces:

Side A RX	PRS receives data on LAN A
Side A TX	PRS transmits data on LAN A
Side B RX	PRS receives data on LAN B
Side B TX	PRS transmits data on LAN B
Side A Alive	PRS receives alive telegrams on LAN A
Side B Alive	PRS receives alive telegrams on LAN B

Table 5: PRS LAN LEDs

4.2 LEDs in the DP section and status LEDs

The LEDs indicate the status of PRS and PROFIBUS DP

MAN	OFF: PRS is in operation mode Automatic ON: PRS is in operation mode Manual
Side A	OFF: DP Slaves are connected to DP Master B ON: DP Slaves are connected to DP Master A
RUN A	OFF: PROFIBUS communication with DP Master A deactivated ON: PROFIBUS communication with DP Master A activated
RUN B	OFF: PROFIBUS communication with DP Master B deactivated ON: PROFIBUS communication with DP Master B activated
Side A Alive	OFF: DP Master A is not alive ON: DP Master A is alive
Side B Alive	OFF: DP Master B is not alive ON: DP Master B is alive

Table 6: PRS DP and status LEDs

Note

In trigger mode **PROFIBUS DP Protocol level** both LEDs **RUN A/B** and **SIDE A/B Alive** are switched on simultaneously, if the PROFIBUS communication with DP Master A is activated.

In trigger mode **PROFIBUS DP Application level** both LEDs **RUN A/B** and **SIDE A/B Alive** are switched separately. **RUN A/B** is switched on, if the PROFIBUS communication is activated. **SIDE A/B Alive** is switched on, if PRS receives alive telegrams from the DP Master A/B.

5 Integrated switches

The integrated switches are rough running to avoid any accidental switching.

5.1 Switch 'Mode A/M' (Operation mode Automatic/Manual)

If PRS is switched from **Automatic** to **Manual** mode, the automatic switch-over detection is deactivated. The PROFIBUS can be switched manually by the button **'Switch A/B'** between DP Master A and B. The selected operation mode is stored in PRS status information buffer that can be read by the connected DP Masters A and B (see chapter 7.2.1 und 8.4.4.1).

To activate the automatic switch-over detection the operation mode 'Automatic' must be activated. In operation mode 'Manual' no automatic switch-over is performed if the operational DP Master system fails.

5.2 'Switch A/B'

'Switch A/B' is a left/right button and returns automatically back to its neutral position if released.

In the operation mode **Manual** the PROFIBUS can be switched between DP Master A (left) and B (right) by this button.

In the operation mode Automatic the PROFIBUS is also switched if the button is pushed but returns to its original state if the button is released.

The selected switch position is stored in the PRS status information buffer that can be read by the connected DP Masters A and B (see chapter 7.2.1 und 8.4.4.1).

6 Operation of PRS

6.1 Redundancy with DP Masters

The implementation of redundant DP Master systems is difficult because the connected DP Slaves only communicate properly with that DP Master that also parameterized and configured the DP Slaves. The take over of the DP Slaves by a second DP Master with a different PROFIBUS address causes a reconfiguration of the DP Slaves. This results in a communication break and re-initialization of the complete PROFIBUS network.

One possibility to implement a seamless take over of the DP Slaves is the dynamic address change of the redundant DP Master (Flying Master principle). This function is partially implemented on different PLC systems. Disadvantages of such a system are the necessary multi master operation as well as the risk of a complete crash of the plant caused by a double station address conflict if the failed DP Master does not reset completely its PROFIBUS communication.

PRS avoids all these disadvantages by switching over electrically the PROFIBUS cable:

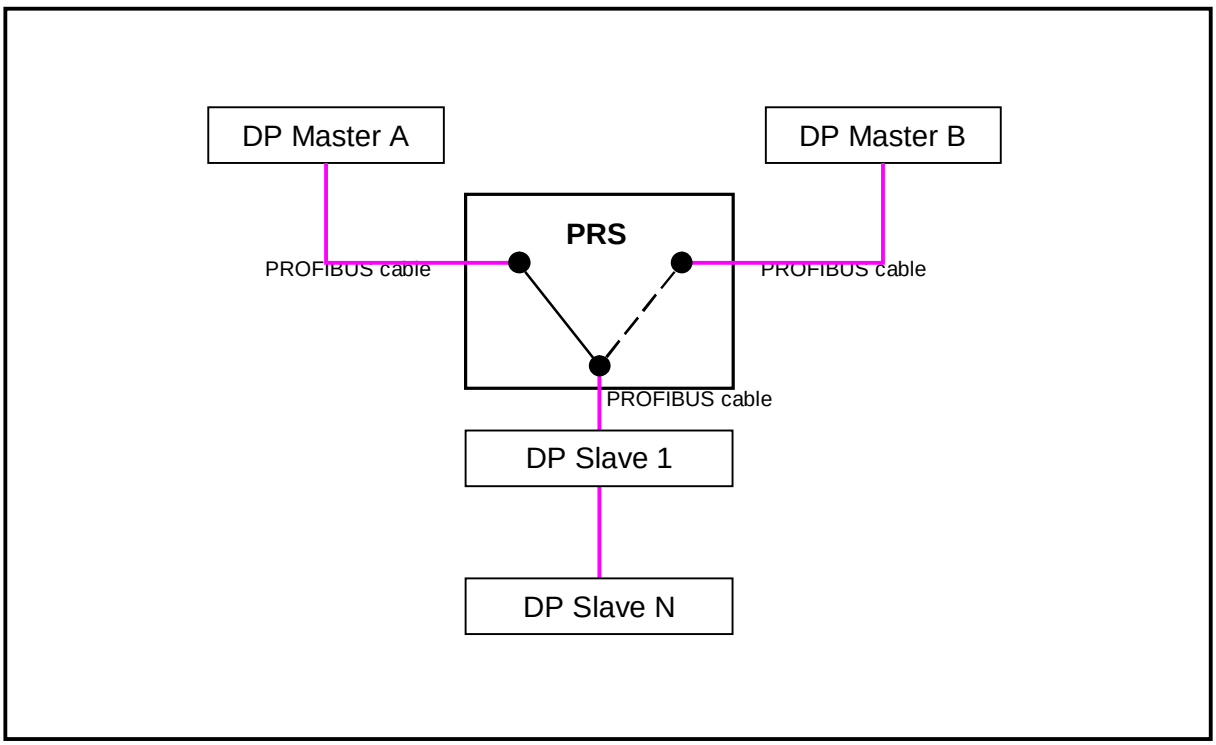

Figure 4: PRS principle function

The PROFIBUS cable is switched electrically between the two DP Masters which has advantages as follows:

- No multi master operation necessary
- 100% prevention of double station address conflict
- Both DP Masters can be identically configured
- Operation with every standard DP Master system possible
- No influencing of the PROFIBUS data traffic through PRS

- The switch-over only takes place if the redundant DP Master is "Alive"
- If both DP Masters are gone, no switch-over will take place

6.1.1 Different behaviour of DP Masters during switch-over

If a seamless switch-over of the DP Slaves without reconfiguration is required, the redundant DP Master system must implement the following functionality:

The redundant DP Master system continues **directly the data exchange with operational DP Slaves without any reconfiguration. Otherwise the DP Slaves perform a reset what will again reset all DP Slave outputs.**

If necessary please contact the DP Master system manufacturer for further information.

6.1.2 Balancing of the PROFIBUS DP Output Data

PRS does not support any balancing of the DP output data between the two DP Master systems:

The subordinate control system (e.g. the PLCs) must guarantee the continuous update of the redundant DP Master system with the actual DP output data (e.g. by an additional Ethernet connection). Otherwise no seamless switch over would be possible.

6.1.3 Single point of failure

There is no single point of failure with the PRS. If PRS is disconnected from the power supply or if the device does develop a fault the Master to Slave communication would continue without interrupted. Only a switch-over is no longer possible.

6.2 Connection of DP Master and DP Slaves

Connect the DP Masters and the DP Slaves as shown in the picture below to the PRS.

The terminations in the PROFIBUS plugs must be switched off if connected to PRS.

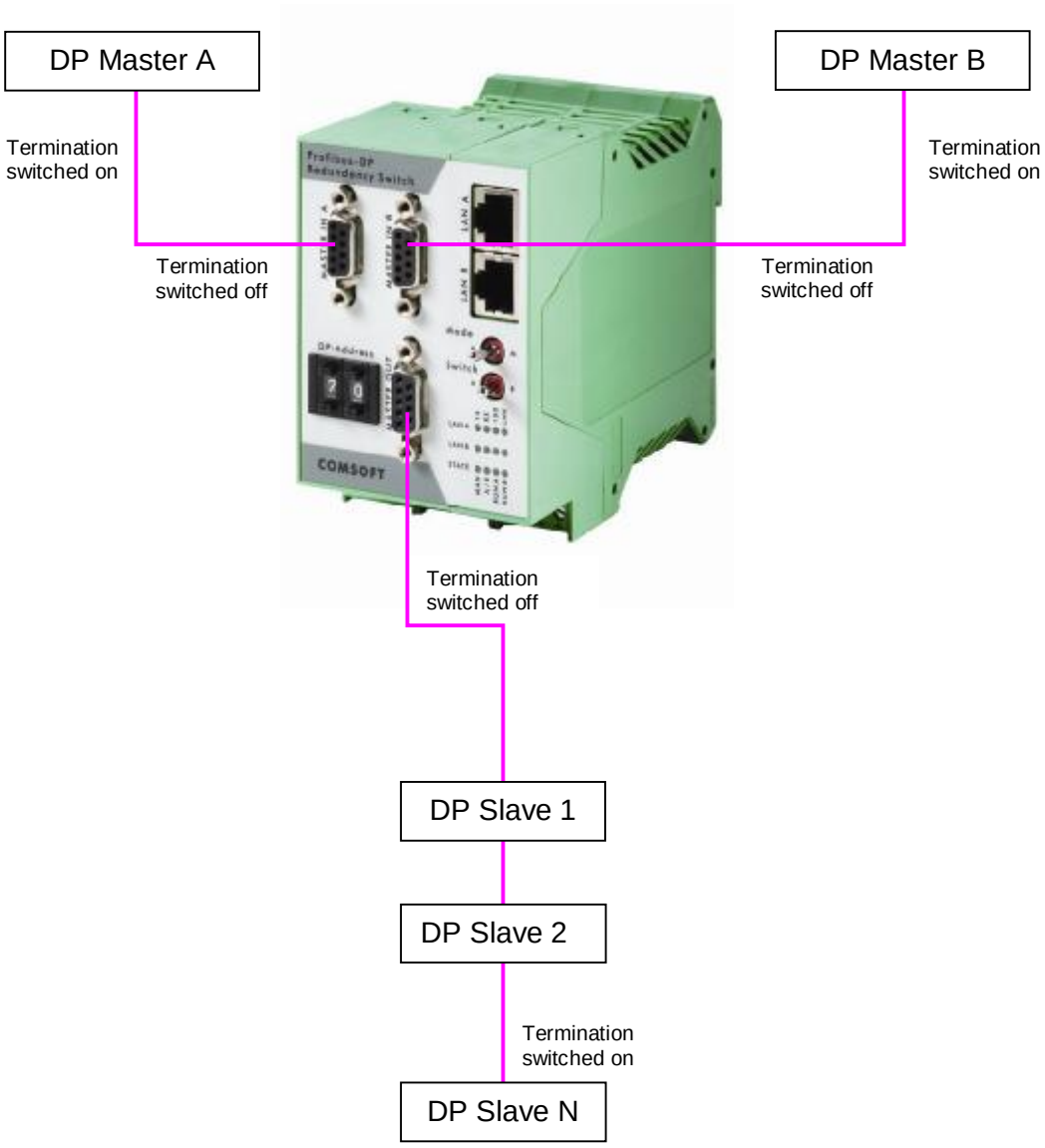

Figure 5: Connection of DP Master/DP Slaves

6.3 Basic configuration via RS232 service interface

If no Ethernet will be used with PRS, the adjustment of the PRS basic parameters can be skipped completely because PRS is adjusted by default to PROFIBUS operation mode.

For configuration of the PRS a serial interface cable (see chap. 2 for pin assignment) and a PC with terminal emulation is required. Connect the serial cable to one of the COM interfaces of your PC and to clamps 6-8 of the PRS. Configure the terminal for the corresponding COM interface with the interface parameters 9600 Baud, 8 Bit, No parity, 1 Stop-Bit. Now, activate or reset the PRS.

After approx. 20 seconds a configuration dialogue will open at the terminal indicating the currently set parameters.

Press any key within five seconds otherwise PRS will continue to start up with the displayed parameters.

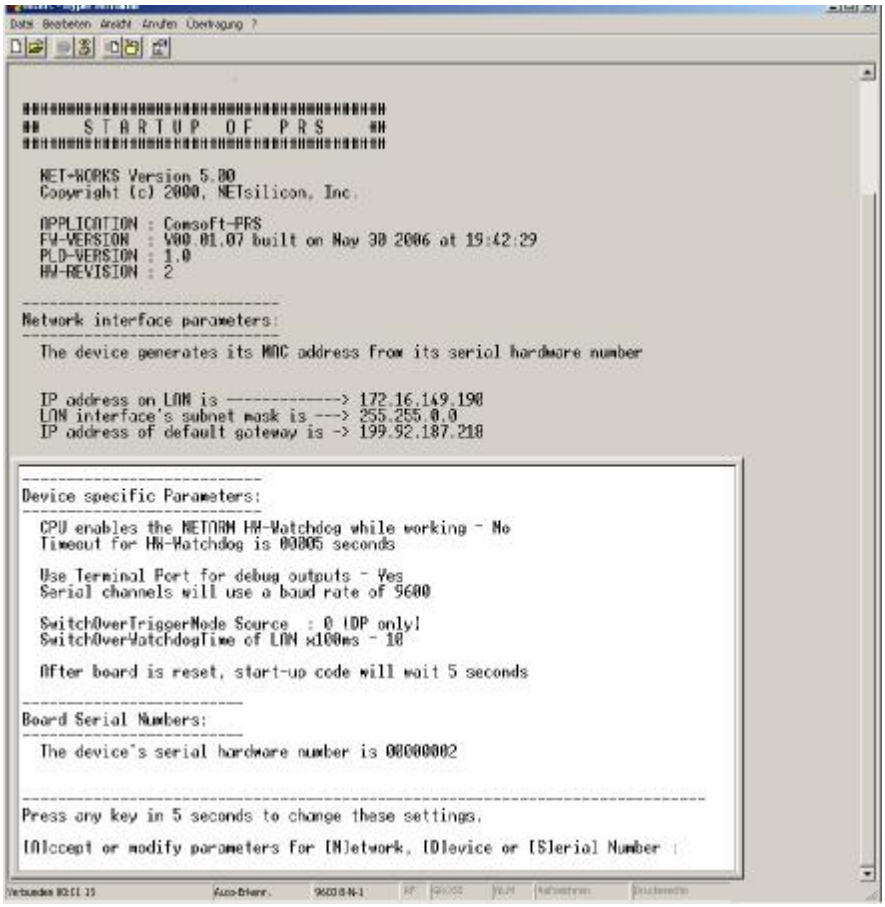

Figure 6: PRS Configuration dialogue

6.3.1 Network parameter

The following parameters can be modified:

- DHCP Yes/No
- TCP/IP address
- Subnet mask

If DHCP is activated PRS gets the TCP/IP address from an available DHCP server.

The necessary Mac address to configure the DHCP server is located on the bottom of the PRS.

Please note that network addresses must not contain leading zeros.

Example:

172.16.1.114, instead of 172.016.001.114.

Each entry is to be concluded with a return. After entry and confirmation of the last parameter (waiting period for the configuration) the PRS stores the entered parameters, performs a reset and displays the configuration dialogue with the modified parameters and a new change option. Entry of parameters may be repeated as often as required.

6.3.2 Device parameter

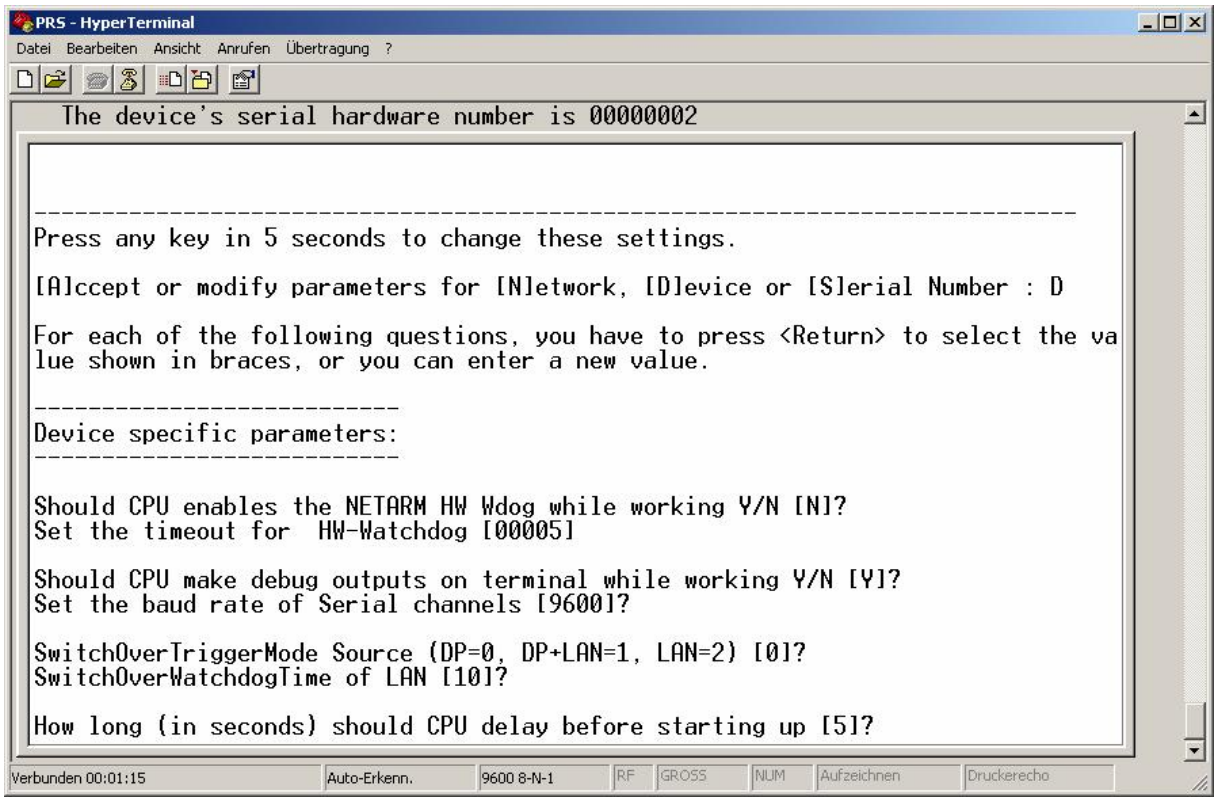

Figure 7: Configuration device parameter

- PRS Hardware watchdog

  PRS will be automatically reboot if the timeout expires, i.e. if a system crash occurs
- Hardware watchdog timeout value in seconds
- Debug messages on RS232 service interface

  PRS transmits during operation debug messages in ASCII format on the RS232 service interface
- Baud rate RS232 service interface

  The baud rate of the RS232 service interface can be changed in the range of 4800 Baud - 115 KBaud (default is 9600 Baud).
- SwitchOverTriggermode

  Determines the basic condition for the automatic switch-over

  The value 1 is only for internal use and must not be configured
  - 0 = The switch-over is triggered by PROFIBUS DP, Ethernet is deactivated
  - 2 = The switch-over is triggered by Ethernet, PROFIBUS DP is deactivated
- Timeout value for Ethernet based alive telegram (SwitchOverTriggermode = 2)

Determines the timeout value in multiples of 100 ms after that a switch-over is performed if no Ethernet based alive telegram was received.

6.4 PROFIBUS DP operation mode

6.4.1 Triggering of a switch-over

The switch-over from the operational DP Master to the redundant DP Master is triggered as follows:

- PROFIBUS failure of the operational DP Master = **Trigger mode PROFIBUS DP protocol level**
- PROFIBUS failure of the operational DP Master or of the overlying application program = **Trigger mode application level**
- Manual switch-over command via DP output data (see chapter 7.1).

6.4.1.1 Determination of the operational and redundant DP Master system

The determination which DP Master works as operational and accordingly as redundant system can be decided by the switch-on sequence of the two DP Masters. Additionally the configuration can be subsequently changed by performing a manual switch-over command. For details refer to chapters 6.4.2.1.1 and 6.4.2.2.1.

6.4.2 Setting of DP Master parameters for redundant operation

To ensure a seamless switch-over the DP Slave watchdog value must be increased in the DP Master parameters to avoid a DP Slave reset during the switch-over.

Rule: $\mathbf{T_{Wdog\ Redundant} = T_{Wdog\ Original} * 4}$

Example for Siemens S7 HW-Konfig ($\mathbf{T_{Wdog}}$ = **Watchdog**):

To change the DP Slave Watchdog , the profile "User defined" must be adjusted.

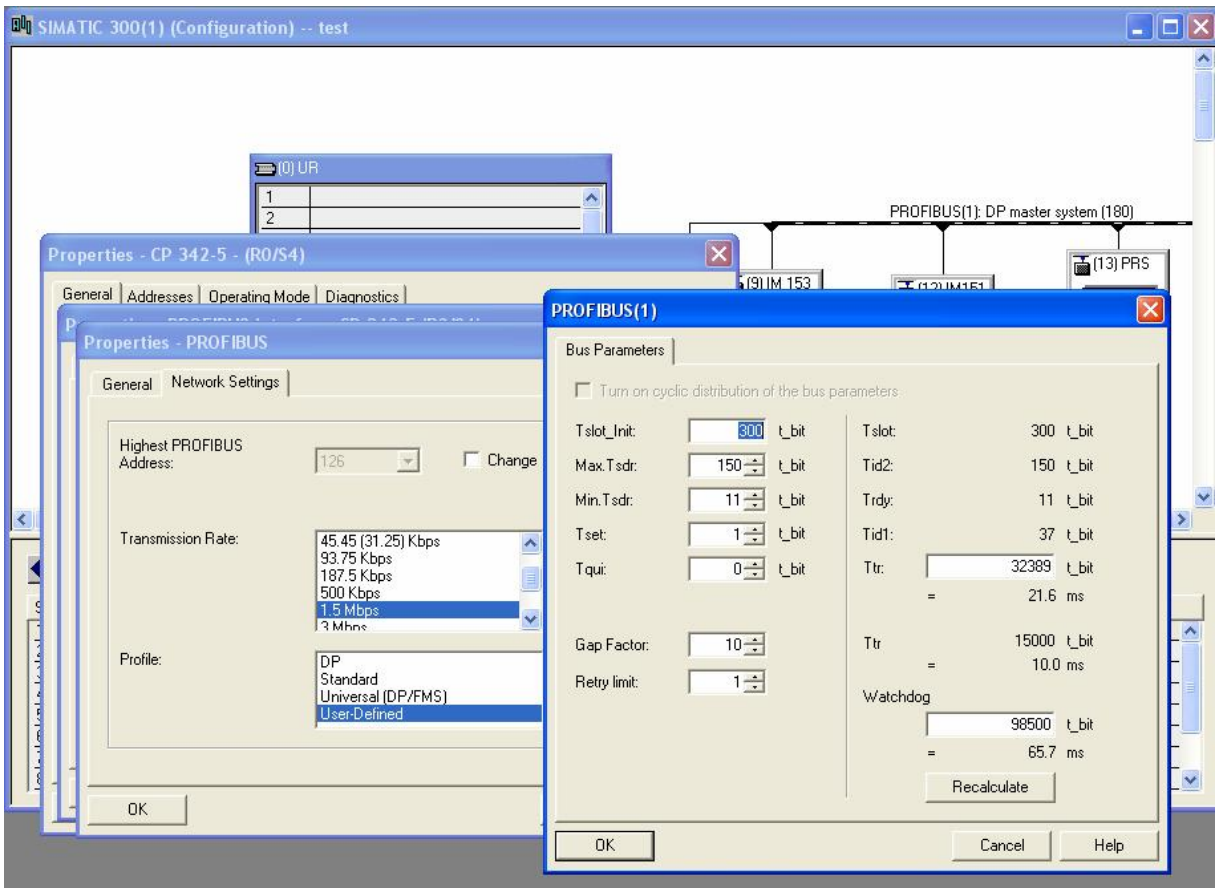

Figure 8: Adjustment of the DP Master parameters

6.4.2.1 Trigger mode PROFIBUS DP protocol level

PRS checks the PROFIBUS traffic of the operational DP Master and switches over to the stand-by Master in case of failure.

Switch-over rules:

- **The switch-over is only performed, if PRS is switched to operation mode 'Automatic'.**
- **The switch-over is only performed, if the redundant DP Master is 'alive'.**
- **The switch-over is performed after half the adjusted DP Slave watchdog value (minimum 10 ms).**
- **If both DP Master failed, no switch-over is performed.**

Proceed with the following steps to setup a redundant DP Master system:

1. Extend both DP Master configurations by PRS using the **COM0A49.gsd file**.
2. Adjust the DP Masters to the trigger mode **PROFIBUS DP Application Level** on both DP Masters.
3. Extend the DP Slave watchdog time in the DP Master parameters on both DP Masters (see chapter 6.4.2).

6.4.2.1.1 Initial switch setting in trigger mode PROFIBUS DP protocol level

The initial switch setting of PRS (A or B) after restart depends on the state of the connected DP Masters.

Basic rule: PRS switches the PROFIBUS to that DP Master which connects at first to the PRS.

The following combinations are possible:

DP Master A passive **DP Master B** passive	**DP Master A** active **DP Master B** active	**DP Master A** active **DP Master B** passive	**DP Master A** passive **DP Master B** active
Switch setting **not** changed	PRS switches to **A**	PRS switches to **A**	PRS switches to **B**

Table 7: Initial switch setting

6.4.2.1.2 DP Master configuration

The DP Master configuration must be extended by the PRS using the appropriate GSD file **COM0A49.gsd**. The PROFIBUS address is adjusted with the integrated address switch:

Figure 9: PROFIBUS address switch

The address range is 0-99. The adjusted address is valid for DP Master A and B.

Adjust the PROFIBUS configuration tool for the PRS to the trigger mode **PROFIBUS DP protocol level**. (This is shown using S7 HW-Konfig as an example):

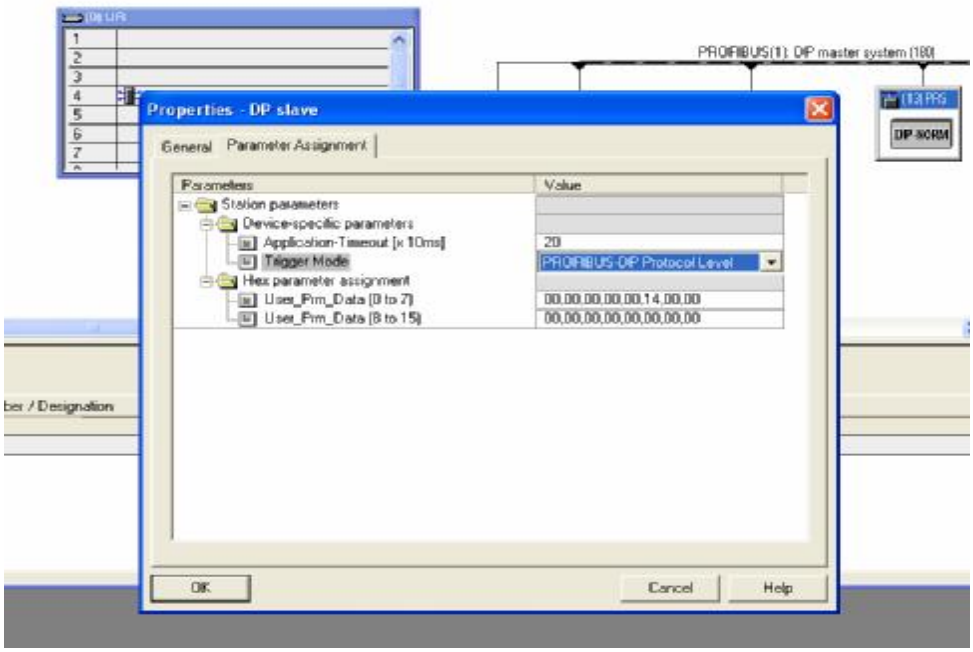

Figure 10: Adjustment of PRS DP parameters

The parameter **application timeout** is not relevant for the trigger mode **PROFIBUS DP protocol level.**

6.4.2.2 Trigger mode PROFIBUS DP application level

PRS checks the PROFIBUS traffic of the operational DP Master as well as an alive counter contained in the PROFIBUS DP output data (see chapter 7.1). The alive counter must be cyclically changed by the application program within the adjusted application timeout. PRS switches over to the stand-by DP Master system in case of failure of the PROFIBUS or expiration of the application timeout.

Switch over rules:

- **A switch-over is only performed, if PRS is switched to operation mode Automatic.**
- **A switch-over is only performed, if the redundant DP Master is alive.**
- **If the PROFIBUS fails, a switch-over is performed after half the adjusted DP Slave watchdog value (minimum 10 ms).**
- **If the alive counter in the alive telegram is no longer changed by the application, a switch-over is performed after the expiration of the application timeout.**
- **If both DP Master failed, no switch-over is performed.**

Proceed with the following steps to setup a redundant DP Master system:

1. Extend both DP Master configurations by PRS using the **COM0A49.gsd** file.
2. Adjust the DP Masters to the trigger mode **PROFIBUS DP application level**.
3. Adjust the **application timeout** value (default: 200 ms) for the alive counter.
4. Extend the DP Slave watchdog time in the DP Master parameters on both DP Masters (see chapter 6.4.2).
5. Implement the alive counter in the superordinate application (see chapter 7.1).

6.4.2.2.1 Initial switch setting in trigger mode PROFIBUS DP application level

The initial switch setting of PRS (A or B) after restart depends on the status of the connected DP Masters.

Basic rule: PRS switches the PROFIBUS to that DP Master which at first becomes alive / changes its alive counter.

The following combinations are possible:

DP Master A not alive **DP Master B** not alive	**DP Master A** alive **DP Master B** alive	**DP Master A** alive **DP Master B** not alive	**DP Master A** not alive **DP Master B** alive
Switch setting **not** changed	PRS switches to **A**	PRS switches to **A**	PRS switches to **B**

Table 8: Initial switch setting

6.4.2.2.2 DP Master configuration

The DP Master configuration must be extended by the PRS using the appropriate GSD file **COM0A49.gsd**. The PROFIBUS address is adjusted at the integrated address switch.

Figure 11: PROFIBUS address switch

The address range is 0-99. The adjusted address is valid for DP Master A and B.

Adjust the DP Master PROFIBUS configuration tool to the **Application-Timeout value (resolution 10 ms)** and to the trigger mode **PROFIBUS DP Application Level**. (This is shown using S7 HW-Konfig as an example):

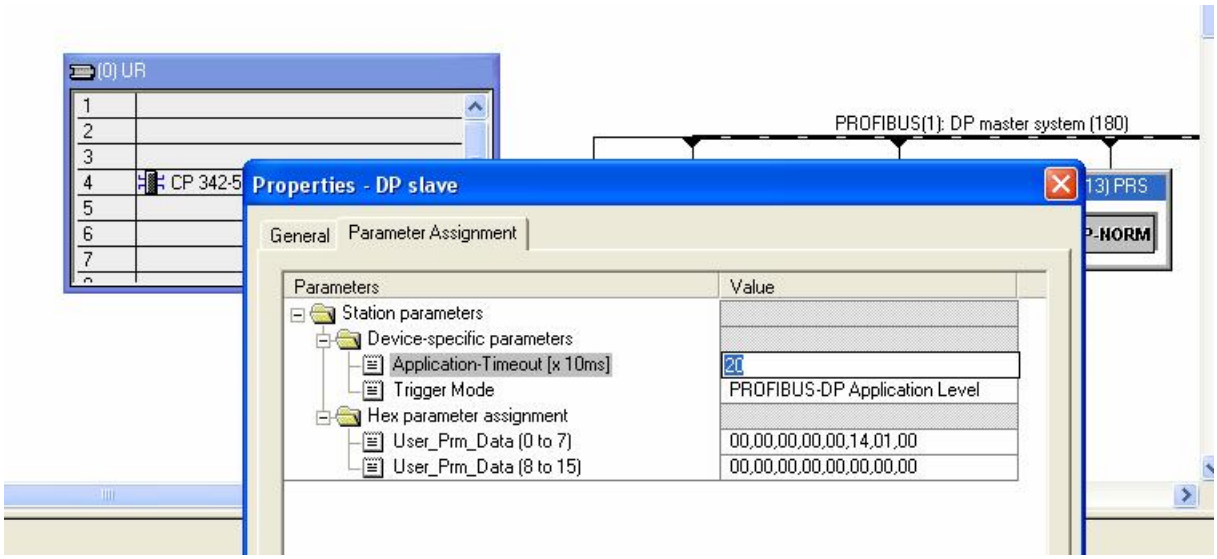

Figure 12: Adjustment of PRS parameters

7 PRS Commands

7.1 PRS PROFIBUS DP output data

The length of the output data is 16 Bytes. Only the first two Bytes are in use, the remaining 14 Bytes are reserved.

Byte 0	Byte 1	Byte 15
Switch-over command	Alive counter	Reserved

7.1.1 Manual switch-over command

Via Byte 0 a manual switch-over command can be performed:

Bit 0: A change from 0 to 1 performs a switch-over to DP Master A

Bit 1: A change from 0 to 1 performs a switch-over to DP Master B

The switch-over is only performed if the bit changes from 0 to 1. After the bit was set it has to be reset by the application, otherwise no more switch-overs are possible.

Switch-over rules:

The manual switch-over is always performed and does not depend on the 'alive' state of the DP Masters.

7.1.2 Alive counter

The alive counter is used in the trigger mode **PROFIBUS DP Application Level.** The superordinate application has to change the alive counter cyclically within the adjusted application timeout (see chapter 6.4.2.2.2), otherwise the PRS switches over to the stand-by DP Master.

The alive mechanism stays inactive after restart of PRS until the alive counter has been changed by the superordinate application. This allows a dedicated start of the alive mechanism by the superordinate application.

7.2 PRS PROFIBUS DP input data

The length of the input data is 16 Bytes. Only the first two Bytes are in use, the remaining 14 Bytes are reserved.

Byte 0	Byte 1	Byte 15
PRS state bits	Echo alive counter	Reserved

7.2.1 PRS state bits

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Reserved	Reserved	Reserved	**0** = DP Master B is **not alive** **1** = DP Master B is **alive**	**0** = DP Master A is **not alive** **1** = DP Master A is **alive**	**0** = PROFIBUS is switched to DP Master **A** **1** = PROFIBUS is switched to DP Master **B**	**0** = PRS is in operation mode **Automatic** **1** = PRS is in operation mode **Manual**

Table 9: PRS state bits

7.2.2 Echo alive counter

PRS echoes the actual value of the alive counter

8 Ethernet based operation

Alternatively to the PROFIBUS DP based operation the switch-over can be also triggered by the two integrated Ethernet channels. This may be useful if the DP Masters additionally include Ethernet channels that can be used to control PRS.

PRS checks the receive of Ethernet based alive telegrams from the two DP Masters. If the operational DP Master fails and the alive timeout expires, PRS switches over to the stand-by DP Master system.

Switch-over rules:

- **A switch-over is only performed, if PRS is switched to operation mode Automatic**
- **A switch-over is only performed, if the redundant DP Master is alive**
- **If no more alive telegrams are received, a switch-over is performed after the application timeout has expired (minimum 100 ms)**
- **If both DP Master failed, no switch-over is performed.**

PRS provides the following Ethernet based features:

- Reception of alive telegrams from the operational and the redundant DP Master system
- Reception of switch-over commands
- Transmission of status information

8.1 Initial switch setting in Ethernet based operation mode

The initial switch setting of PRS (A or B) after restart depends on the state of the connected DP Masters.

Basic rule: PRS switches the PROFIBUS to that DP Master which at first transmits an alive telegram.

The following combinations are possible:

DP Master A not alive **DP Master B** not alive	**DP Master A** alive **DP Master B** alive	**DP Master A** alive **DP Master B** not alive	**DP Master A** not alive **DP Master B** alive
Switch setting **not** changed	PRS switches to **A**	PRS switches to **A**	PRS switches to **B**

Table 10: Initial switch settings

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8.2 Typical Ethernet based PRS configuration

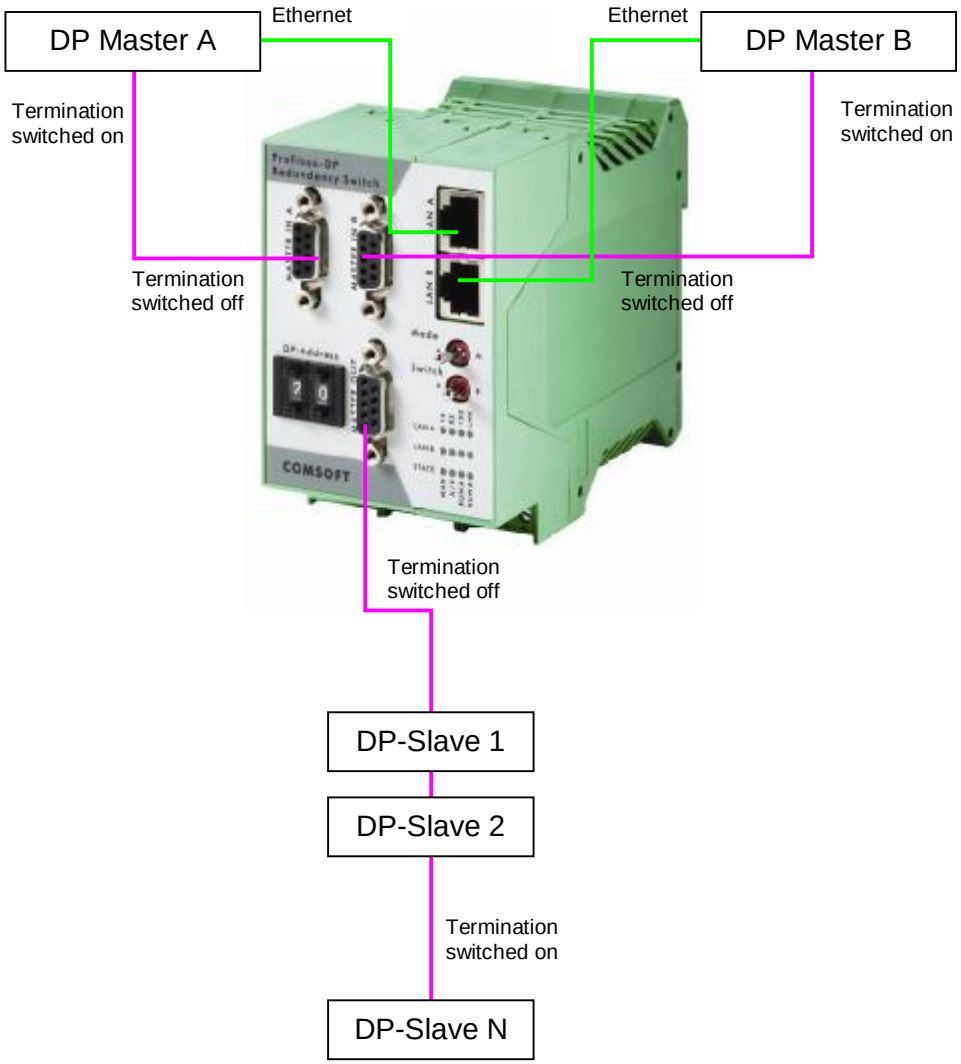

Figure 13: PRS Ethernet based operation

8.3 Configuration of the Ethernet based communication

PRS allows IP address configuration via DHCP server or alternatively a direct setting of the IP address (see chapter 6.3).

The Ethernet interface is based on **UDP**. Both Ethernet interfaces can be reached via the same IP address and different ports for DP Master A and B:

DP Master A: Port **0xC000**

DP Master B: Port **0xC001**

8.4 Ethernet communication structure

8.4.1 UDP commands

Basic frame structure:

Request

Command	Length	optional Data
UINT_16	UINT_16	Array of UINT_8[]

Response

Command	Status code	Length of the following data	optional Data
UINT_16	UINT_16	UINT_16	Array of UINT_8[]

8.4.1.1 Alive

With the first transmission of an alive telegram the alive watchdog for the appropriate DP Master is activated. PRS confirms the first alive telegram with the status code 0x0002. This is no error message, but a confirmation that the alive watchdog is started.

Afterwards the DP Master has to transmit cyclically alive telegrams within the adjusted timeout interval. PRS confirms every alive telegram with status code 0x0000. If the DP Master stops transmitting alive telegrams, the alive timer expires and a switch-over is performed.

Request

Command	Length	optional Data
0200	0000	-

Response to the first alive request

Command	Status code	Length of the following data	optional Data
0200	0200	0000	-

Response to all subsequent alive requests

Command	Status code	Length of the following data	optional Data
0200	XXXX	0000	-

8.4.2 Deactivating the Alive-Watchdog-Timer

The command stops the activated Alive-Watchdog-Task or the appropriate DP Master A or B.

Request

Command	Length	optional Data
0300	0000	-

Response

Command	Status code	Length of the following data	optional Data
0300	XXXX	0000	-

8.4.3 Manual switch-over A/B

Switch-over PROFIBUS to the appropriate DP Master A or B.

Swich-over rules:

The manual switch-over is always performed and does not depend on the alive status of the DP Masters.

The DP Master which activated the last switch-over is stored in the status information buffer.

Request

Command	Length	optional Data
0000	0000	-

Response

Command	Status code	Length of the following data	optional Data
0000	XXXX	0000	-

8.4.4 Reading of the PRS status buffer

If this command is received, the PRS responses with the status buffer. The command could be send over both ports 0xC000 or 0xC001.

Request

Command	Length	optional Data
0400	0000	-

Response

Command	Status code	Length of the following data	optional Data
0400	XXXX	32	Status buffer

8.4.4.1 Format of the PRS status buffer

The status buffer consists of 32 Bytes. Byte 15-31 are reserved for internal use.

Byte	status message	Format	State/Value
0	HW Rev	UINT_8	Revision number hardware 0…255
1	SW Rev 00.Hi.Lo.Sub	UINT_32	Software version in binary format
5	Hardware serial number	UINT_16	Hardware serial number 0...65535
7	DHCP configuration	UINT_8	0 DHCP = OFF 1 DHCP = ON
8	Hardware watchdog	UINT_8	0 OFF 1 ON but not active 2 ON and active
9	Trigger mode	UINT_8	0 DP 1 DP and LAN 2 LAN
10	Operation mode	UINT_8	0 Manual 1 Automatic
11	Actual Switch position	UINT_8	0 A 1 B
12	Status DP Master A	UINT_8	0 Alive and time out not expired 3 Not Alive, timeout expired and switch over performed 4 Not Alive, time out expired and no switch over performed 7 Alive not started
13	Status DP Master B	UINT_8	
14	Switch-over cause DP Master A	UINT_8	0 No switch over performed 1 Time out 2 Manual switch over command
15	Switch over cause DP Master B	UINT_8	
16-31		Reserved	

Table 11: PRS UDP status buffer

8.4.5 Status codes

Status code	Meaning	
0x0000	Success:	Command successful performed
0x0100	Error:	No switch-over because complementary DP Master not functional
0x0200	Status:	Alive watchdog task activated
0x0300	Error:	Command does not exist

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